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#### TEETH WHITENING CHEWING GUM

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#### Abstract

A gum containing papain as a whitening agent in a quality comprising between 0.2 and 5% by weight with respect to the total formulation, together with gum base and other additives suitable for the formulation and to improve its protective properties for dental enamel and its organoleptic characteristics. The gum is presented in the form of a coated tablet and the papain is found in the coating. A typical gum formulation comprises papain (1-5%), gum base (18-21%), xylitol (5-45%), sorbitol (19-70%), maltitol (8-10%) together with other additives. The use of the gum eliminates dental stains with a minimal abrasion and the system hydrolyzes the peptide bonds in dental plaque and tartar.

#### Description

Teeth whitening chewing gum.

### Field of the invention

The present invention refers to a chewing gum suitable for whitening the teeth that contains papain as the whitening agent, together with a gum base and other additives appropriate for its formulation.

### Antecedents of the invention

For some time, a form has been sought for obtaining dental care with anticariogenic protection of the teeth and improvement of their appearance by eliminating the plaque and stains that darken them and make them unsightly.

There are several ways to protect the teeth against attack by bacteria and stains deposited in the teeth; among them, brushing with an appropriate toothpaste, using mouthwashes and gargles and chewing sugarless chewing gums that tend to protect the teeth, a habit that can gradually be extended because in certain circumstances (for example, after lunch or a light snack, or when traveling), it may be difficult or impossible to brush one's teeth, or it may even be done to reinforce the action of the brushing.

Dental enamel is made up mostly of water and hydroxyapatite and presents a translucent white color. Although it appears to be a flat and perfectly smooth and polished surface, seemingly resistant to any microfiltration, enamel in fact has a very rough surface, replete with cracks, breaks and microfractures that function as reliable tracks for microfiltration from the surface to the interior of the tooth. Dental enamel is subjected to continuous physical and chemical attacks throughout our lifetimes. The chemical aggressions are visible in aging, cavities, and erosions, while the physical aggressions can be noticed in various kinds of abrasions, fractures and fissures.

With the passage of time and eating, smoking and drinking habits, the teeth begin to become colored and show stains, an unsightly effect that can eventually inhibit the natural smile in people who are affected. It is thought that two of every three adults suffer some type of dental discoloration. There are numerous and widely diverse causes that provoke dental discoloration, some of them are extrinsic (ingestion of coffee, tea, cola drinks, wine, and food coloring, tobacco, poor hygiene with great quantities of plaque deposits and tartar, and dental aging) while others are intrinsic (tetracyclines, fluorosis, trauma and yellowish hue of the enamel).

The process of discoloration of a white enamel implies a chain of events. In general, salivary proteins adhere to the dental surface on a clean and clear enamel, forming the so-called protein plaque. Later, the bacteria of the oral environment are incorporated into this protein plaque and they transform it into the so-called bacterial plaque. The protein plaque offers a place where the bacteria can establish themselves as its characteristic mucilaginous consistency allows firm fixation of the bacterial cells. At that time, food residues are fixed to the bacterial plaque

and fermented, producing energy and nutrients for the bacterial cells that build and excrete to the exterior long chains of polysaccharides, using for this the sugars of the medium, increasing fixation to the enamel. If this is not eliminated, all these structures begin to harden from the deposition of calcium, and little by little, calculus or tartar appears. Microorganisms inside the bacterial plaque die because of the deposit of the calcium salts, but on the surface they fix more proteins and bacteria, and because of this, the dental calculus continues to grow in a constant way. All these structures allow organic and synthetic colorings such as those present in coffee, tea, wine, cola drinks, foods and tobacco to attach themselves to the dental surface, producing an unwanted unsightly effect.

On the other hand, the process of aging of the enamel is owing to the continuous and dynamic exchange of film, bacterial plaque, tartar and oral fluid between the oral medium and the dental surface and vice versa. Minerals, colorings and bacteria from dental plaque, oral fluids or foods spread through the dental enamel, developing internal deposits that transform the clear and translucent aspect of the enamel into many shades of discolored enamels.

In general, all these processes contribute to discoloration of the dental enamel that can eventually inhibit the smile of the sufferer.

Certain toothpastes that are traditionally used to eliminate stains and whiten the teeth exercise their function by the abrasive effect of various insoluble substances. These toothpastes, however, produce significant attacks on the dental enamel, eliminating part of it together with its stains or tints, and this can produce damage to the enamel that may facilitate the appearance of cavities and erosions due to the elimination of the natural defensive structure of the enamel with the consequent dentine hyperesthesia. Less aggressive teeth whiteners are also known that contain papain as the whitening agent (Spanish Patent P9401832). Nevertheless, the use of toothpastes is limited by the opportunity to brush that may not be available on certain occasions; for example, dining out, trips, etc.

There is therefore a need to provide an appropriate new medium to eliminate dental stains and whiten the teeth that overcomes the inconveniences previously mentioned. This objective can be reached by using the whitening chewing gum provided by this invention that in daily use accomplishes a gradual clearing of the dental enamel, allowing by this means for a whiter and more brilliant appearance to be achieved.

#### Detailed description of the invention

The present invention provides a teeth whitening chewing gum that contains papain in a quantity between 0.2 and 5% by weight with respect to the total weight of the chewing gum formulation. Papain is a proteolytic enzyme of low specificity appropriate to cleaning the salivary protein plaque that exercises a whitening function on dental surfaces. Papain hydrolyzes proteins,

amides and esters of amino acids and its activity is associated with the presence of free sulphydryl groups in its active center. The low specificity of the substrate allows this enzyme to act on many protein products.

Papain is extracted from latex obtained from immature fruits of *Carica papaya* (papaya), and the obtained extract also contains variable quantities of chymopapain. In dealing with a product of natural origin, the enzymatic activity present in the extract can vary, and for this reason, it is convenient to use a rated enzymatic extract the proteolytic activity of which has been adjusted to a constant value. Thus, for the elaboration of the chewing gum of this invention, an enzymatic extract is preferably used that contains papain with a proteolytic activity of approximately 6,000 U-USP/mg (units of the Pharmacopeia of the United States (U-USP)).

The optimal working temperature of papain is between 40 and 60°C; above this temperature, an irreversible inactivation is produced by protein denaturalization. For this reason, this chewing gum that contains papain is presented in the form of a coated tablet, the papain making up part of the external coating layer of the chewing gum that is not heated and not of the gum base that is heated to temperatures higher than approximately 65°C. Papain is active at a pH of between 3 and 9 and outside those values the enzyme is inactive. In general, it is convenient that the chewing gum that contains papain has a nearly neutral pH; that is, approximately 7, for the purpose of guaranteeing the activity of the enzyme without demineralizing the enamel.

Papain exercises a cleaning action on bacterial plaque and tartar, breaking down the glucoprotein chains and lipoproteins coming from the salivary fluid as well as the bacterial excretory activity of mucilaginous substances that attach themselves to the enamel, allowing its colonization by bacterial plaque and the fixation of calcic salts on these structures that act as support (tartar). Therefore, in attacking these structures, they ameliorate the processes associated with excessive plaque and tartar, such as cavities and periodontal illness, and thus offer an effective protection of the teeth.

The formulation of the chewing gum provided by this invention; from now on, the chewing gum of the invention, contains besides the gum base, some additives that make up, together with the additives usually used for the production of chewing gums, other additives with the purpose of improving the properties protective of dental enamel of the chewing gum of the invention, as well as its characteristic organoleptics. As a non-limiting example, the chewing gum of the invention may contain some selected anticavity additives of the sweetener group, as well as stabilizing and moistening agents, pH regulators (buffers), emulsifiers, colorants, flavorings, coating and polishing agents, protectors against humidity, and mixtures of these in variable quantities. Some of the additives that may be used exercise more than one function.

The gum base can be present in the formulation of the chewing gum in a quantity between 18 and 21% by weight of this formulation.

The formulation of the chewing gum of the invention may contain xylitol compound (1,2,3,4,5-pentapentol) that presents different activities, on the one hand exercising moistening and refreshing action while on the other presenting activity such as acariogenic sweetening and inhibiting the reception and metabolism of the glucose in certain bacteria, avoiding the formation of organic acids that attack the hydroxyapatite of dental enamel, dissolving it and initiating the appearance of cavities. Xylitol has the ability to reduce the adhesiveness of *Streptococcus mutans*, the microbial agent directly related to the processes of cavity formation. Therefore, xylitol is not just acariogenic, but also inhibits cavities; that is, it is anticariogenic in human beings. Xylitol can be present in the formulation of the chewing gum of the invention in a quantity between 5 and 45% by weight.

The formulation of the chewing gum of the invention can also contain sorbitol, a sweetener that is not metabolized in organic acids under normal conditions, avoiding the formation of cavities. Sorbitol also increases the formation of saliva, which has great importance in the prevention of cavities. Sorbitol can be present in the formulation of the chewing gum of the invention in a quantity between 19 and 70% by weight.

Another additive that can be present in the formulation of the chewing gum of the invention is maltitol that can be present in this formulation in a quantity between 8 and 10% by weight with respect to the total weight of the formulation of the chewing gum of the invention.

Glycerin may be used as a stabilizer that also presents moistening properties in a quantity between 0.5 and the 1% by weight with respect to the total weight of the formulation of the chewing gum of the invention.

Advantageously, the formulation of the chewing gum of the invention also contains a buffer that keeps the medium at a nearly neutral pH for the purpose of guaranteeing the activity of the papain. By way of example, a solution of dicalcium phosphate may be used as a buffer in an appropriate quantity to yield the desired pH.

The chewing gum of the invention may contain such other additives as emulsifiers; for example, lecithin, colorings, for example, titanium dioxide, flavorings, for example, mint essential oil, etc.

In a particular and preferred embodiment of the present invention, the chewing gum is presented in the form of a coated tablet in which the coating contains the papain. Because this enzyme becomes inactive at temperatures above 60°C, the papain cannot be added directly to the gum base as this is heated to temperatures above 65°C during the production process of the chewing gum. In this case, the chewing gum of the invention may also contain carnauba wax and optionally, beeswax, as well as a sugar glaze to obtain a polished surface and increase its protection against humidity.

In a particular embodiment, a whitening chewing gum is provided that presents the following formulation:

Component	% by weight with respect to total weight
Papain	0.2-5
Gum base	18-21
Xylitol	5-45
Sorbitol	19-70
Maltitol	8-10
Other additives*	

(\*selected from among stabilizers, emulsifiers, humectants, dissolution regulators, flavorings, colorings, coating and polishing materials, etc., in variable quantities].

The presentation of papain in chewing gum form presents numerous advantages, and among these are:

- it ensures that the active component, papain (proteolytic enzyme able to attack the main protein matrix of plaque, tartar and stains of the teeth, eliminating them and producing an action of dental whitening) is distributed throughout the entire mouth and reaches places of difficult access where brushing is frequently incomplete owing to lack of time or technique;
- it promotes enhanced secretion of saliva, which has decisive importance for yielding an anticariogenic effect and general oral protection, as it is now known that the saliva protects against cavities in a highly effective way owing to the salivary enzymatic system; and
- it allows the papain to remain in the mouth a sufficiently long time to act with even greater efficacy than when it is applied in a toothpaste.

The chewing gum of the invention can eliminate dental stains with a minimal degree of abrasion because the present system in the chewing gum hydrolyzes the peptide bond between dental plaque and tartar.

Tests carried out with the chewing gum of the invention in tablet form have shown that its daily consumption removes dental stains, whitens the teeth and that it is effective even in smokers and drinkers of coffee and tea (Example 2) and that it is able to remove the film deposited on dental enamel (Example 3).

The invention also provides a procedure for the production of this chewing gum that contains papain in the form of a coated tablet that is made up of the stages of pouring the gum base into a paddle agitator preheated to a temperature of approximately 65°C, beating the gum base until it begins to soften, adding the selected additives and cutting the resultant chewing gum into the form and size of the desired tablets. Next, the coating is added to the tablets, for which

the appropriate quantity of papain is dispersed into a sorbitol solution and this dispersion is applied to the tablets. Afterward the flavoring and coloring are added, and to finish, the tablets are polished; for example, with carnauba wax powder, and dried. The dried tablets are again polished and glazed to obtain greater protection against humidity.

The following examples serve to illustrate particular ways of carrying out the object of this invention, without being considered as limiting its scope.

#### Example 1

##### Preparation of a whitening chewing gum

Whitening chewing gum tablets are prepared with the following composition:

Component	% by weight with respect to total weight
Papain	2.5
Xylitol	10.5
Sorbitol (E-420)	49.5
Gum base	19.5
Maltitol (E-965)	8.9
Dicalcium phosphate (E-341)	6.9
Mint essential oil	0.8
Carnauba wax (E-903)	0.035
Confectioners' sugar	0.115
Glycerin (E-422)	0.70
Titanium dioxide (E-171)	0.55

For production of the tablets, the procedure that is described next is followed. The gum base is added to a mixer with a jacket that is provided with a paddle agitator, preheated to approximately 65°C. When the base begins to soften, the glycerin is added and part of the sorbitol (in powder form) is added, approximately 50-60% of the total sorbitol and mixed. Next, approximately a third of the maltitol syrup is added and mixed. Then approximately 10% of the sorbitol (powder) is added, mixed, a second third of maltitol syrup is added, mixed, and approximately 10% of the sorbitol (powder) is added and mixed. The remaining third of the maltitol syrup is then added, mixed, the balance of the sorbitol (powder) is added, mixed, the xylitol is added, mixed, and the mint essential oil is added and mixed. Finally, the dicalcium phosphate is added over a period between 5 and 7 min.

Upon concluding the previous operations, the chewing gum lot produced is discharged onto some appropriate receptacles and transported to a chewing gum laminator.

The produced lot is loaded into a double screw pre-extruder that feeds the extruder for the laminator. The chewing gum is extruded in a wide, thick sheet, which is dusted on both sides

with calcium carbonate to avoid tackiness during the lamination. Each set of rollers of the laminator reduces the thickness of the chewing gum until the dimension is reached that is desired for the tablet. The sheet of chewing gum is then introduced into two sets of rollers for cutting, the first set cutting it into ribbons and the second across to produce the tablets. The tablets are collected on trays, weighed and allowed to cure in a cold room for approximately 24 h.

For the coating of the tablets, a certain quantity of weighed tablets is placed in each coating well. The coating of the tablets begins with a sorbitol solution at 70% and sorbitol (fine powder). Next, the appropriate quantity of papain is weighed for each coating well and it is dispersed into the sorbitol solution. Additional sorbitol solution is added to the mixture and it is applied to the tablets. Next, the flavoring and coloring are added. When the tablets have reached the desired weight, they are polished with powdered carnauba wax, placed in trays and allowed to dry. When the tablets are dry, they are again polished with a mixture of carnauba wax and beeswax and glazed to protect against humidity.

### Example 2

#### Test of ability to remove dental stains with whitening chewing gum

This test was carried out to prove the ability to remove dental stains using the chewing gum tablets obtained in Example 1.

For realization of this test, 30 patients of a private dental clinic were selected, all with different intensities of discoloration of their teeth.

Of the 30 patients:

- 15 were smokers, some smoking very little and others smoking heavily (more than 20 cigarettes/day);
- 20 drank from 1 to 3 cups of coffee daily;
- 5 drank 2 cups of tea daily; and
- 12 stated they drank at least 1 glass of a cola-based soft drink (cola) per day.

The color measurement was only carried out for the 6 front teeth. The teeth were divided into buccal and lingual surfaces. Initial photos were made and the intensity of the initial color was established by means of a Kodak colorimeter.

The teeth were also evaluated with a VITA guide of color shades. Three different appraisers established the shade of the color of each tooth.

The patients were divided in two groups:

- the patients of the first group (Group A) brushed their teeth with their usual toothpastes, following their ordinary habits and they did not chew the chewing gum of Example 1; and

- the patients of the second group (Group B) brushed their teeth with their usual toothpastes, following their ordinary habits, and they were given instructions so that they chewed 3 pieces of chewing gum daily, 1 in the morning and 2 in the afternoon.

Groups A and B were formed with patients who presented the same proportion of stains and discoloration and they were told to maintain their normal habits (smoking, drinking coffee, tea, or cola) during the time that the test lasted (45 days).

#### Results:

- Group A: The patients showed an increase of dental stains, especially on the lingual surfaces.
- Group B: The patients showed a statistical color improvement with a significant retreat of the dental stains on the buccal surfaces and slightly lesser on the lingual surfaces. The patients made reference to a "pleasant cleaning sensation" and the heavy smokers declared that they had felt an improvement in their breath.

#### Conclusions:

Because only the group that had chewed the chewing gum of Example 1 (Group B) showed a statistically significant removal of dental stains, it can be concluded that the chewing gum:

- removes dental stains;
- whitens the teeth; and
- is effective even for smokers and drinkers of coffee or tea.

#### Example 3

##### Test of film cleaning

The incisors of some dogs were clipped to obtain samples of buccal enamel of approximately 10 mm<sup>2</sup>. The surfaces of the enamel were sanded and nicked to accelerate the accumulation of stains.

Next, the samples were exposed to a solution composed of tea, coffee, cola and mucin. The exposures were for 10 min every 30 min. At the end of 7 days, a fine dark film could be seen on the surfaces of the enamel.

The quantity of "in vitro tincture" was graded photometrically. Samples with high tint values were used.

The samples were mounted on a specially designed mechanical chewing machine, equipped with a chewing gum tablet at the end of its arms and intermittent cooling with water.

The contact tension of the chewing gum on the surface of the enamel was adjusted to 150 grams (g). The samples received 800 blows. Every 30 min the used chewing gum tablets were exchanged for new tablets and they were placed in the ends of the arms of the artificial chewing machine.

On concluding this mechanical procedure, the samples were washed, dried and classified by their tint grade as described previously.

#### Calculations:

The difference between the tint values before and after the mechanical chewing was calculated, as well as the mean error and standard deviation.

#### Results:

A statistically significant ability to clean the film was observed after exposure to the chewing gum, the conclusion reached being that the samples could have experienced a greater removal of tint and film if it had been combined with conventional tooth brushing.

#### Claims

1. Teeth whitening chewing gum that contains papain in a quantity between 0.2 and 5% by weight with respect to the total weight of a chewing gum formulation.
2. Chewing gum according to Claim 1 that additionally contains 18 to 21% gum base by weight.
3. Chewing gum according to Claim 1 that additionally contains 5 to 45% xylitol by weight.
4. Chewing gum according to Claim 1 that additionally contains 19 to 70% sorbitol by weight.
5. Chewing gum according to Claim 1 that additionally contains 8 to 10% maltitol by weight.
6. Chewing gum according to Claim 1 that additionally contains a buffer that yields an approximately neutral pH.
7. Chewing gum according to Claim 1 that additionally contains an additive selected from the group including emulsifiers, stabilizers, colorings and flavorings.
8. Chewing gum according to Claim 1 that contains a coating layer that contains papain.
9. Chewing gum according to Claim 1 that contains the following formulation:

Component	% by weight with respect to the total
Papain	0.2-5
Gum base	18-21
Xylitol	5-45
Sorbitol	19-70
Maltitol	8-10

together with other additives selected from among stabilizers, emulsifiers, moisteners, buffers, flavorings, colorings, coating and polishing materials and materials to protect against humidity.

10. Chewing gum according to Claim 9 that contains the following formulation:

Component	% by weight with respect to the total
Papain	2.5
Xylitol	10.5
Sorbitol	49.5
Gum base	19.5
Maltitol	8.9
Dicalcium phosphate	6.9
Mint essential oil	0.8
Carnauba wax	0.035
Confectioners' sugar	0.115
Glycerin	0.70
Titanium dioxide	0.55

11. A procedure for the production of a chewing gum that contains papain in a quantity between 0.2 and 5% by weight with respect to the total weight, in the form of a coated tablet that consists of the stage of adding a coating layer that contains the papain onto the tablet of chewing gum previously obtained.

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**REPORT ON STATE OF THE ART**Int. Cl.<sup>6</sup>: A23G 3/30**RELEVANT DOCUMENTS**

Category	Documents cited	Claims affected
X	GB 824680 A (Merck and Co., Inc.) December 2, 1959, page 3, column 2, lines 74-93.	1, 2, 8, 11
Y		3-7, 9
Y	WO 7507621 A1 (Wm. Wrigley, Jr., Company) March 23, 1995, the entire document	3-7, 9
A	ES-2079325 A1 (Biocosmetics, S.L.) January 1, 1996.	

**Category of documents cited**

X: particularly relevant

Y: Particularly relevant in combination with another or others of the same category

A: Reflects state of the art

O: Refers to unwritten disclosure

P: Published between the date of priority and presentation of the application

E: Prior document, but published after the application presentation date

This report has been prepared

 for all the claims

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